Jiro TANAKA* & Mitsuo CHIHARA*:

Taxonomic study of the Japanese crustose brown algae (2) *Ralfsia* (Ralfsiaceae, Ralfsiales) (Part 1)**

田中次郎*・千原光雄*:

日本産殻状褐藻の分類学的研究 (2) イソガワラ属 (第1部)

Ralfsiaceae Hauck, Meeresalg. Deutsch. u. Oesterr. in Rabenhorst's Kryptogam.-Flora v. Deutsch, Oesterr. u. Schweiz. 2nd ed. 2: 318 (1883).

Stragulariaceae Strömfelt, Om Algenveg. vid Islands Kuster. 49 (1886).

Thallus crustose, expanded; vegetative filaments firmly or loosely joined laterally with one another; unilocular sporangia arising laterally on vegetative filaments having terminal paraphyses; plurilocular reproductive organs intercalary, arising from the cells; chloroplast one to several in each cell.

Type genus: *Ralfsia* Berkeley.

Key to the genera of the Ralfsiaceae from Japan

1. Chloroplasts plate-shaped and one per cell .... *Ralfsia*
1. Chloroplasts disc-shaped or irregular and several per cell.
    2. Plurilocular reproductive organ bearing three sterile cells in a terminal uniseriate series .... *Endoplura*
    2. Plurilocular reproductive organ bearing a single terminal sterile cell on each reproductive filament .... *Diplura*

Ralfsia Berkeley in Smith, Engl. Bot. Suppl. 3: pl. 2866 (1843)

Thallus crustose, flat and expanded, more or less circular in outline, attached to the substratum with or without rhizoids; vegetative erect filaments arising from a basal layer, straight or curved, branched or simple; both types of reproductive organs borne on the same or on separate thalli; unilocular sporangia clavate, obovoid to pyriform, sessile or pedicellate arising from the supporting cell of paraphysis; paraphyses clavate; plurilocular reproductive organs intercalary, arising from a cell located in the submerged part of the erect filament, composed of one to four rows of plurilocular reproductive filaments with one to several terminal sterile cells; chloroplasts mostly plate-shaped, generally one per cell; hairs in tufts, scattering over thallus.

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Type species: *Ralfsia fungiformis* (Gunnerus) Setchell et Gardner.

Ralfsia is the largest genus in the Ralfsiaceae and contains about 25 species. The genus is widely distributed from the Arctic Sea to tropical waters. Two subgenera Euralfsia Batters and Stragularia (Strömfelt) Batters have been recognized by several workers. However, as their distinction is not suffuciently clear, they are not adopted in the present study.

Key to the species of *Ralfsia* from Japan

1. Thallus with imbricated lobes or layers ....*R. fungiformis*

1. Tahllus without imbricated lobes or layers 2

2. Thallus thick, mostly more than 400 μm thick; vegetative erect filaments often branched, more or less curved 3

2. Thallus thin, mostly less than 400 μm thick; vegetative erect filaments simple and straight.. 6

3. Thallus having a symmetrically bilateral structure; unilocular sporangia pedicellate, with 3-6 stalk cells ....*R. expansa*

3. Thallus having a unilateral structure; unilocular sporangia sessile........ 4

4. Unilocular sporangia mostly more than 100 μm long.............*R. integra*

4. Unilocular sporangia mostly less than 100 μm long 5

5. Plurilocular reproductive organ bearing a single terminal sterile cell .... *R. verrucosa*

5. Plurilocular reproductive organ bearing three uniseriate terminal cells...... .... *R. endopluroides*

6. Unilocular sporangia pedicellate with a single stalk cell (and plurilocular reproductive organ bearing two terminal uniseriate sterile cells) .... *R. pedicellata*

6. Unilocular sporangia sessile (and plurilocular reproductive organs lacking).. 7

7. Unilocular sporangia about 100 μm long.......................*R. bornetii*[1]

7. Unilocular sporangia about 50 μm long ....*R. tenuis*

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[1] A stage in the life cycle of species of *Petalonia*, according to Edelstein *et al.* (1970).

1) **Ralfsia verrucosa** (Areschoug) J. Agardh, Spec. Alg. 1 : 62 (1848) ; Reinke, Atlas Deut. Meeresalg. 1 : tab. 5, figs. 1-13 (1889) ; Yendo, Bot. Mag. Tokyo **32**: 65 (1918) ; Tokida, Mem. Fac. Fish. Hokkaido Univ. 2: 82 (1954) ; Noda, Sci. Rep. Niigata Univ. ser. D **6**: 26 (1969).

Cruoria verrucosa Areschoug, Linnaea 17: 264, pl. 9, figs. 5-6 (1843).

Thallus thick, crustose, flat and expanded, epilithic or epizoic, dark brown on the surface, rust-colored on the under surface, almost circular in outline when young, later becoming irregular and often confluent, attaining 8 cm in diameter, 350-600 μm thick, at first firmly attached to the substratum, sometimes with rhizoids when young, but when old tending to be free, especially in the middle part; the surface of thallus uneven or verrucose; thallus pseudoparenchymatous, composed of upwardly curved filaments which arise from the basal part and taper toward the surface, showing an unilateral structure; a border between medullary and cortical layers indefinite; cells in lower and middle parts of thallus 12-16 μm broad and 1.5-3 times as long as the width; tufts of hairs arising from the middle part of the thallus; cells often filled with many granular storage substances; chloroplast single per cells, plate-shaped, located in the upper of the cell; two kinds of reproductive organs borne on the surface of separate thalli, scattered throughout the thallus making patches; unilocular sporangia arising on supporting cells of paraphysis, clavate, pyriform to obovoid, 50-60(-72) μm long and 20-25 μm broad, without stalk cell; paraphyses clavate, slender, 70-120 μm long, composed of 6-10 cells, with its terminal cell being somewhat spheroidal, about 7 μm broad and 1.2 times as long as the breadth, and with its basal cell being about 4 μm broad and 3 times longer than the width; plurilocular reproductive organs infrequent, composed of a single plurilocular reproductive filament which is 40-50 μm long and about 5 μm broad, with a single terminal sterile cell which is 8-11 μm long and about 6 μm broad.

Habitat: Growing on rocks and pebbles, or epizoic on *Tetraclita* sp., sometimes mixed with *Endoplura aurea* as found in the middle intertidal zone in Shimoda, Shizuoka-ken.

Type locality: Norway (as *Cruoria verrucosa* Areschoug)

Geographical distribution: Widely distributed in the subarctic to the subtropical through the temperate regions. Common in the middle and northern parts of Japan.

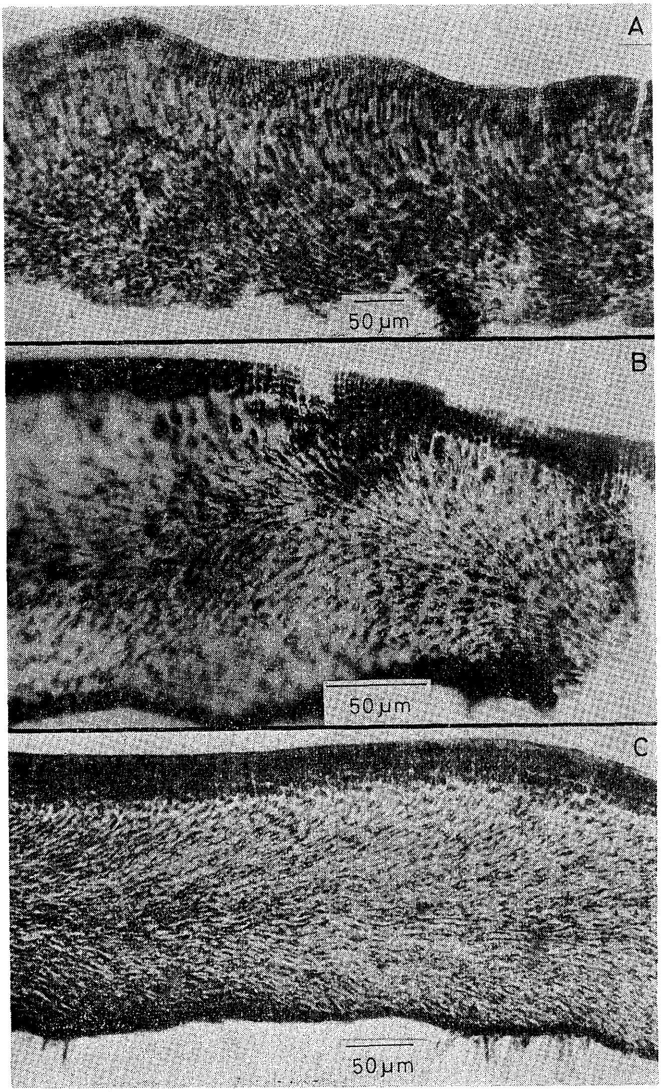

Fig. 1. Cross sections of vegetative thalli of three species of *Ralfsia*. A: *R. verrucosa*, showing a unilateral structure of the thallus. B: *R. expansa*, showing a symmetrically bilateral structure of the thallus and a marked demarcation between cortical layer and medullary one. C: *R. fungiformis*, showing a symmetrically bilateral structure and a marked demarcation as in B.

Representative specimens examined: Kamakura, Kanagawa-ken, June 15, 1977 (TKB[1] 1303); Shimoda, Shizuoka-ken, June 22, 1974 (TKB 1302); Shimoda, Shizuoka-ken, Feb. 9, 1978 (TKB 1304); Noto, Ishikawa-ken, Aug. 4, 1977 (TKB 1306); Shiogama, Miyagi-ken, April 24, 1978 (TKB 1305).

The present alga agrees well with *Ralfsia verrucosa* in many respects, such as the structure of the thallus and the reproductive organs. With regards to the length of paraphyses and unilocular sporangia, there have been considerably varing values reported so far by several workers. In general, the paraphyses of the specimens examined in the present study are shorter than those of the European specimens (*e.g.* Hamel's (1935) are 100-200 μm long). The unilocular sporangia of the present alga are also slightly shorter than those of the European ones.

The plurilocular reproductive organs were first observed by Kuckuck (1894) and later by Hamel (1935) and Jaasund (1964). Jaasund has given the pictures of this organ, based on the specimens from northern Norway, and it agrees well with ours in the shape and size. In Japan, Yendo (1918) first reported the occurrence of this species from Shiribeshi, Hokkaido, and later Okamura (1936) considered it to be a common taxon along the coast of Japan. In fact, we have made many collections of this species from different localities, including Mie-, Ishikawa-, Shizuoka-, Miyagi- and Ibaraki-ken.

Ralfsia verrucosa is similar to *R. expansa* in many respects. However, it is easily distinguished from *R. expansa* by the following criteria. The thallus of *R. verrucosa* has a unilateral structure, composed of only upwardly curved vegetative filaments arising from the basal layer, with unclear border between the medullary and the cortical portions. On the other hand, in *R. expansa* the thallus has a bilaterally symmetrical structure, and the border between the medullary and the cortical portions is more clearly discernible. Moreover, *R. verrucosa* has sessile and relatively short unilocular sporangia, measuring 50-60 μm long, while *R. expansa* has longer ones (75-95 μm long) with several stalk cells.

The present species also resembles *R. pacifica* Hollenberg, a species known to be widely distributed along the Pacific coast of the North America. As to the differences between the two species, Hollenberg (1969) stated as follows:

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[1] TKB: the herbarium of the University of Tsukuba.

"Thalli of *R. verrucosa* are usually multistratose as a result of overgrowth of one lobe over another or periodic or seasonal growth. Such stratification seems not to occur in *R. pacifica*. Certain authors describe the plurangia of *R.*

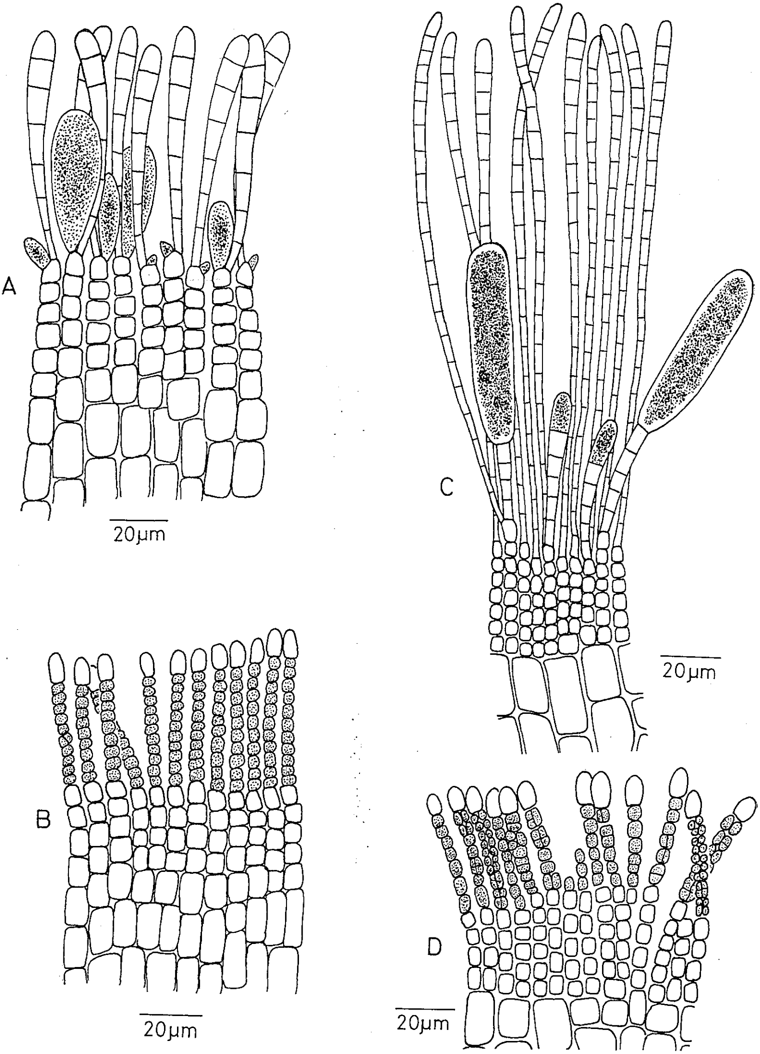

Fig. 2. Unilocular sporangia (A, C) and plurilocular reproductive organs (B, D) of *R. verrucosa* (A, B) and *R. expansa* (C, D).

verrucosa as partly biseriate, whereas those of *R. pacifica* seem to be regularly uniseriate". We have found these criteria to be true and useful, but with exceptions; *e.g.*, the thalli often do not produce overgrown lobes and the plurilocular reproductive organs are uniseriate. The size of unilocular sporangia should be used for distinguishing these two species: *R. pacifica* has fairly long sporangia, measuring 70-90 μm long, according to Hollenberg (1969). We have also measured the size of this reproductive organ, using the lectotype specimen of *R. pacifica* deposited in the Herbarium of the Smithsonian Institution, and confirmed it to be true.

2) **Ralfsia expansa** (J. Agardh) J. Agardh, Spec. Gen. et Ord. Fucoidearum 63 (1848); Weber van Bosse, Siboga-Exped. Mongr. **59a**: 146, fig. 45 (1913); Børgesen, Dansk Bot. Ark. 2: 189, figs. 146-148 (1914); Taylor, Mar. Alg. East. Trop. Subtr. Coast Amer. 243 (1960); Earle, Phycologia 7: 143 (1967).

Myrionema expansum J. Agardh, Alg. Liebm. 7 (1847).

Thallus crustose, expanded, growing on rocks or dead coral, light brown or reddish brown, circular in outline when young, with concentric lines on the surface, which become indefinite or irregular when old, often confluent, attaining 4 cm or more in diameter and 200-800 (-1100) μm in thickness, first attached firmly to the substratum with its under surface, sometimes by means of many rhizoids, later tending to be entirely free, the surface of the thallus smooth at first, later becoming uneven especially in the central portion; thallus pseudoparenchymatous, composed of two parts which with a clear border between; medullary layer showing a symmetrically bilateral structure, composed of upwardly and downwardly curved filaments arising from the central part of the thallus, whose cells are 15-25 μm broad and 2.5-4 times as long as the width; the terminal cells of the downwardly curved filaments spheroidal, giving rise to rhizoids; cortical layer 50-70 μm thick, arising from the terminal cells of upwardly curved filaments, composed of erect filaments; erect filaments simple or sometimes branched, slightly tapering toward the surface, where cells are 4-6 μm broad and 1-1.2 times as long as the width; hairs in tufts, arising from the middle part of the thallus, frequent; chloroplast plate-shaped, single per cell; reproductive portions in sori, scattered throughout the thallus; unilocular sporangia and plurilocular reproductive organs sometimes borne on the same thallus; unilocular sporangia long and ellipsoidal or clavate or obovate, 75-95(-110) μm long, 23-35 μm broad, pedicellate with 3-6 stalk cells, borne on erect filaments with paraphyses; paraphyses long and clavate, slender, composed of 12-16 cells, whose size is 100-190(-220) μm long, with terminal cells being 5-6 μm broad and 0.8-1.4 times as long as the width, and basal cells being 2.5-3 μm broad and 4-7 times as long as the width; plurilocular reproductive organs 40-65 μm long, initially uniseriate, later biseriate, bearing one terminal sterile cell; sterile cell 5-6 μm broad and 1.2-2.2 times as long as the width.

Habitat: Growing on rocks or dead corals in the middle and the lower intertidal zone in the southern parts of Japan.

Type locality: Vera Cruz, Mexico (as *Myrionema expansum* J. Agardh)

Geographical distribution: Distributed in warm seas, including Mexico, Malaysia and Danish West Indies. Common in the warmer seas in Japan.

Representative specimens examined: Hachijo-jima, Tokyo, Aug. 3, 1965 (TKB 1310); Tsushima Islands, Mar. 17, 1969 (TKB 1311); Iriomote-jima, Okinawa-ken, Apr. 2, 1973 (TKB 1312); Okinawa-jima, Okinawa-ken, Mar. 9, 1974 (TKB 1313); Goto Islands, Nagasaki-ken, Oct. 15, 1977 (TKB 1314); Amami-oshima, Mar. 26, 1978 (TKB 1316); Shimoda, Shizuoka-ken, Feb. 8, 1978 (TKB 1315).

In the light of the descriptions and illustrations given by Weber van Bosse (1913) and Børgesen (1914), we have found the present alga to be identical with *Ralfsia expansa*. We have had an opportunity to examine several authentic specimens of this species deposited in the Herbarium of the University of California, Berkeley, and found ours agree well with them.

Specimens examined at the University of California, Berkeley are as follows: Arue Point, Tahiti Society Islands, May 24, 1922 (UC 261285); Arue Point, Tahiti Society Island, June 27, 1922 (UC 261260); Tahiti, June, 1925 (UC 667796); Sainte Norie (Mortinique), Mar. 1930 (UC 687751); Garden Key, Dry Tortugas, Florida, June 4, 1926 (UC 315088).

This species is characterized by the following features: 1) the marked symmetrically bilateral structure of thallus, 2) having long ellipsoidal unilocular sporangia with 3-6 stalk cells at the base and 3) having biseriate plurilocular reproductive organs with a large terminal sterile cell. Of these three, Weber van Bosse has used the symmetrically bilateral structure as the primary criterion for distinguishing *R. expansa* from *R. verrucosa*. However, according to Reinke (1889), *R. verrucosa* has both unilateral and bilateral structures, al-though he has given illustrations showing only the bilateral structure of thalli. From our own observations and the published data available, it can be concluded that the unilateral structure is a typical character of *R. verrucosa* and is commonly found, while the symmetrically bilateral structure is rarely found. In agreement with Weber van Bosse, we would like to use this character as one of the criteria important for distinguishing these two species. The size of unilocular sporangia is also useful as a specific diagnostic character for these species, as mentioned previously in this paper. Børgesen (1914) figured a unilocular sporangium with a single stalk cell in *R. expansa* from the Danish West Indies, in contrast to the present alga, which has a sporangium with multicellular pedicels. We consider it to be a result of differences in strains.

3) **Ralfsia fungiformis** (Gunnerus) Setchell et Gardner, Univ. Calif. Publ. Bot. **13**: 11 (1924) et **8**: 499 (1925); Nagai, J. Fac. Agr. Hokkaido Imp. Univ. **46**: 40 (1940); Tokida, Mem. Fac. Fish. Hokkaido Univ. **2**: 81 (1954); Hollenberg, J. Phycol. **5**: 295, fig. 29 (1969).

Fucus fungiformis Gunnerus, Fl. Norv. 107 (1772).

Ralfsia deusta (Ag.) J. Agardh; Yendo, Bot. Mag. Tokyo **23**: 123 (1908). (non *Ralfsia deusta* Berkeley, in Engl. Bot.).

Thallus thick, crustose, epilithic, dark brown, attached to the substratum in the central portion by means of many rhizoids, more or less circular in outline when young, attaining 5 cm or more in diameter and 0.5-1.2 mm in thickness when old, with imbricated lobes or layers; thallus composed of two fairly clearly demarcated parts; medullary layer showing a marked symmetrically bilateral structure, cells 8-12 μm broad and 1.5-5 times as long as the width, and the lowermost cells spheroidal, measuring 10-14 μm in diameter; cortical layer 30-120 μm thick, consisting of straight filaments of 4-15 cells, which taper toward the surface; cells in lower part 6-8 μm broad and 1.5 times as long as the width; cells in the uppermost part 4-6 μm broad and 1-2 times as long as the width; rhizoids multicellular, growing downward from the lowermost cells, chloroplast single per cell and plate-shaped; both kinds of reproductive organs borne on the same thallus; unilocular sporangia without pedicel, clavate, pyriform, up to 180 μm long and 36 μm broad; paraphyses 165-200 μm long, composed of 5-7 cells; plurilocular reproductive organ intercalarly arising from several cells of upper cortical layer, 90-180 μm long, with 3-6 sterile cells on the top; hair pit not seen.

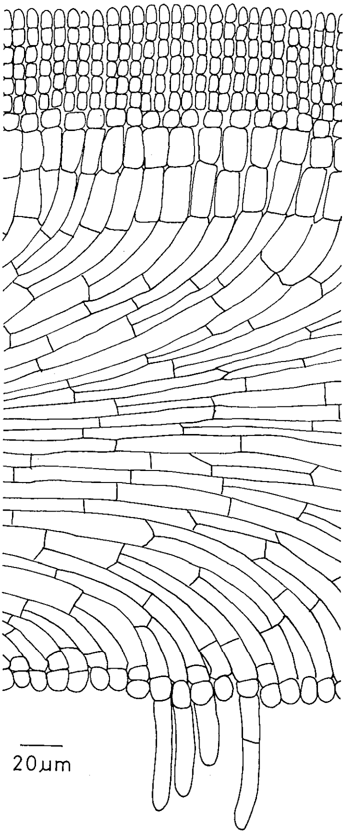

Fig. 3. Cross section of a vegetative thallus of *R. fungiformis*.

Habitat: Growing on rocks in the middle to the lower intertidal zone, often in tide pools.

Type locality: Northern Norway (as *Fucus fungiformis* Gunnerus).

Geographical distribution: Widely distributed in the circumpolar regions, including the west coast of North America, from the Bering Sea to northern California, Greenland, Iceland, the Arctic Sea, eastern Canada, northern Norway. Common in the northern parts of Japan, especially in Hokkaido.

Representative specimens examined: Shikotan-shima, Kurile Islands, July, 1934 (SAPS 15597[1]); Matsuwa, Kurile Islands, Aug. 17, 1935 (SAPS 21914[1]); Horomushiro-shima, northern part of Kurile Islands, Aug., 1935 (SAPS 19859[1]); Enrumu-misaki, Hokkaido, July, 1975 (TKB 1320); Shoya, Hokkaido, May, 1976 (TKB 1321).

Though the specimens examined in the present study are sterile, they agree very well with *Ralfsia fungiformis* described and figured by Setchell and Gardner (1924, 1925), Tokida (1954) and Hollenberg (1969). We have also examined several authentic specimens of this species deposited in the Herbarium of University of California, Berkeley, recognizing our specimens to be identical with *R. fungiformis*.

Specimens examined in University of California, Berkeley: Sitka, Alaska, July, 1917 (UC 1019141); the same (UC 395227); the same (UC 402196); St.

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[1] By the courtesy of Prof. M. Kurogi of Hokkaido University, to whom we wish to express our thanks.

Laurence Island, Alaska, coll. Otto W. Geist (UC 466108).

In the present description, we refer to Tokida's study (1954) as to the reproductive characteristics, since no fertile specimens have been available.

Ralfsia fungiformis is a species markedly characterized by having imbricated lobes or layers. The species is also well characterized anatomically by the combination of the following features: 1) the thallus has a symmetrically bilateral structure, 2) demarcation between the medullary and the cortical layers is clear, 3) unilocular sporangia have no pedicel and 4) plurilocular reproductive organs have 3-6 terminal sterile cells.

Edelstein *et al.* (1968) studied *R. fungifornis* from eastern Canada and described the morphology of reproductive organs, together with the process of their formation. The Japanese specimens agree well with their specimens, including the number of sterile cells borne on the plurilocular reproductive organs and the shape and the dimension of both reproductive organs.

References

Børgesen, F. 1914. The marine algae of the Danish West Indies. Part 2. Phaeophyceae. Dansk Bot. Ark. **2**: 159-222. Edelstein, T., L. Chen & J.M. McLachlan, 1968. Sporangia of *Ralfsia fungiformis* (Gunn.) Setchell et Gardner. J. Phycol. **4**: 157-160. ——, —— & —— 1970. The life cycle of *Ralfsia clavata* and *R. bornetii.* Can. J. Bot. **48**: 527-531. Hamel, G. 1935. Phéophycées de France. **2**: 81-176. Hollenberg, J.H. 1969. An account of the Ralfsiaceae (Phaeophyta) of California. J. Phycol. **5**: 290-301. Jaasund, E. 1964. Marine algae from northern Norway, III. Bot. Mar. **6**: 129-133. Kuckuck, P. 1894. Bemerkungen zur marinen Algenvegetation von Helgoland, I. Wiss. Meeresunters. Biol. Anstalt Helgoland, N.F. **1**: 225-263. Okamura, K. 1936. Nippon Kaiso-shi. 964 pp. Tokyo. Reinke, J. 1889. Algenflora der westlichen Ostsee deutschen Antheils. Ber. Kommiss. Unters. deutsch. Meere. **6**: 1-101. Setchell, W.A. & N.L. Gardner 1924. Phycological contributions, VII. Univ. Calif. Publ. Bot. **13**: 1-13. —— & —— 1925. The marine algae of the Pacific coast of North America, III. Melanophyceae. Univ. Calif. Publ. Bot. **8**: 383-898. Tokida, J. 1954. The marine algae of southern Saghalien. Mem. Fac. Fish. Hokkaido Univ. **2**: 1-264. Weber van Bosse, A. 1913. Liste des algues du Siboga, I. Siboga-Expeditie Monographie **59a**: 1-186. Yendo, K. 1918. Notes on algae new to Japan. Bot. Mag. Tokyo **32**: 65-81.

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本報告は日本産殻状褐藻の分類学的研究の第二報で，まず代表的な分類群であるイソガワラ科の3属 *Ralfsia*, *Endoplura* 及び *Diplura* の検索を与え，ついでそのうちの一属イソガワラ属の邦産種8種の検索を与えた。さらにそれらのうちから *Ralfsia verrucosa*, *R. expansa* 及び *R. fungiformis* の3種について解剖図を添えて分類上の記述を行った。

○田村・堀田・河野3氏の見解を読んで（原　寛*・岩槻邦男**） Hiroshi Hara & Kunio Iwatsuki: Comment on Tamura, Hotta and Kawano's view

杉本氏「植物界」の有効出版性についての本田他6名の見解発表（以下「本田他」と略記）に対し，田村 堀田 河野3氏の見解（以下「田村他」と略記）が前号に発表された。

「本田他」では，「植物界」の有効出版性についての見解を国際的に知らせるのが目的であったため，この問題をとりあげて発表した経緯については簡単に触れただけだった。そこで，誤解を招くことがないように，いくつかの点について説明を補足しておきたい。「田村他」では，50年あまもり「無視するという極めて常識ある対応をとって」きたのだから，そのままそっとしておいた方がよかったという意向のようである。しかし，表現の自由を尊重する立場からも，杉本氏の分類学的見解は相応に評価するべきである。「本田他」が論じているのは，分類学的な内容についてではなくて，その命名上の有効出版性についてである。分類学的研究には，「研究」と「命名」の両面があり，その両者は区別して扱かうべきであるというのが国際的に通用している基本的理解である。「研究」の発表は良心的に自由に行われればよい。しかし，「命名」については，「植物命名国際規約」が合意されている現在，これに従うのは当然のことであり，その取扱いが形式的になるのも止むを得ない。「田村他」の，「それが引用されなくても，それは見落した側のせいではなくて発表した側のせいである」という意見は，「研究」の発表に対しては言えるかもしれないが，「命名」についてはそれでは済まされない。見落された論文については再検討が必要であり，再び命名が変更され混乱が起ることもありうる。

杉本氏「植物界」については，2年程前に，コピーを送ってほしいという手紙が国外から筆者の一人のところに届いている。もし，説明もなしにそのコピーが出廻るということになれば，日本の植物の学名に混乱を起すようになることは十分予測される。日本植物の学名の問題だからといって日本国内だけのことではなく，学名の問題は国際的なものである。混乱が起きてから論議を始めても手遅れであり，予見できる混乱に対して予め手を打ってその混乱を未然に防ぐよう努力することは分類学に携わるものの務めで